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### ***In Situ* Stabilization of Soil Lead Using Phosphorus and Manganese Oxide: An EXAFS Study**

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**Introduction:** In addition to the formation of insoluble lead (Pb) compounds as a mean of reducing Pb bioavailability, adsorption is another potentially important process controlling the bioavailability of Pb in soils. Less attention has been given to manganese (Mn) oxides, even though they are known to adsorb Pb more strongly than any other metal (hydr) oxides. A laboratory incubation study revealed that reductions in bioavailable Pb in stomach phase extractions (from physiologically based extraction procedure-PBET) upon addition of P or P and Mn oxide (cryptomelane) ranged from 15 to 41% and 23-67%, respectively, in five metal contaminated soils or mine spoils compared to the unamended control (1). X-ray diffractometry analysis supported the PBET results, indicating that more “pyromorphite-like minerals” formed in the presence of both P and Mn oxide compared to the control. We believe that EXAFS studies would be useful to further verify changes in Pb chemistry upon these treatment additions before adapting this technology to remediate Pb contaminated residential soils.

**Materials and Methods:** This study was conducted to evaluate the effects of P and Mn oxide on soil Pb chemistry in Pb/Zn smelter slag material from Dearing, KS. Cryptomelane was used as the representative Mn oxide. Nine treatments were used: zero P, 5000 mg of P as triple superphosphate (TSP) or phosphate rock (PR), 2500 and 5000 mg of Mn oxide/kg, and combinations of Mn oxide and P as TSP or PR. The treated samples were incubated for 4, 12, and 24 weeks at a gravimetric moisture content of 20% and 25°C. Subsamples were air dried and sieved through a stainless steel sieve ( $\leq 250 \mu\text{m}$ ) before analyzed by XAFS. Data was collected in fluorescence mode using a Lytle detector to encompass the XANES region of Pb. Principle component analysis was used to decipher the XANES spectra relative to known reference compounds (adsorbed Pb, Pb carbonate, Pb-sulfur, and Pb phosphate (pyromorphite)).

**Results:** Figure 1 shows that pyromorphite was present in the control prior to P addition and this results are in agreement with XRD results (1). The addition of P as TSP shows increase in the amount of Pb present as pyromorphite. More importantly, these data also suggest that more pyromorphite formed in the presence of both P and Mn oxide compared to the control.

**Acknowledgements:** The research work presented herein do not, necessarily, reflect Agency policy. Mention of trade names of commercial products does not constitute endorsement or recommendation for use.

### **Reference:**

Hettiarachchi, G.M., G.M. Pierzynski, and M.D. Ransom. 2000. *In situ* stabilization of soil lead using phosphorus and manganese oxides. Environ. Sci. Technol. 21:4614-4619.

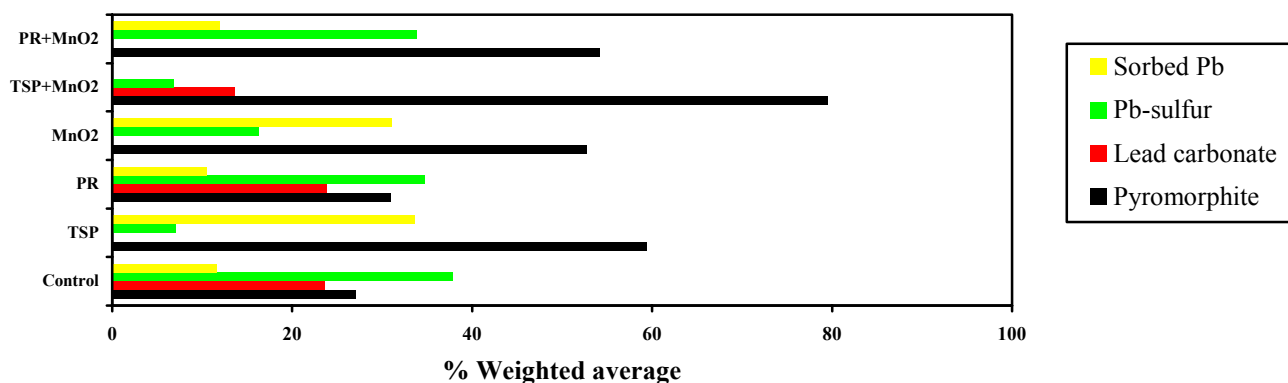


Figure 1: The weighted averages of Pb minerals for different treatments of Dearing at 4 weeks